

CLAIMS

1. Pointing apparatus for the correct positioning of the distal locking screws of an intramedullary nail, characterised in that it includes:

- 5 • means designed to receive one or more images of the section of nail to be fixed with the screws;
- means designed to process the images to obtain the coordinates of the centre of the hole and the inclination of the axis;
- means designed to position an instrument in correspondence with said axis, and align said instrument with said axis.

10 2. Pointing apparatus as claimed in claim 1, characterised in that it includes:

- 15 • a head which includes a reference designed to be viewed by an X-ray, fluoroscopic or similar apparatus, and means of guiding a surgical instrument;
- means designed to move said head close to the end of the nail containing the holes, to allow said external apparatus to take simultaneous images of the end of the nail with the holes and the reference integral with the terminal;
- 20 • means designed to read said image and calculate the position and inclination of its axis on the basis of the shape and dimensions of the hole shown in the image;
- means designed to read the image of said reference and calculate the relative position and inclination of said reference, and consequently of said head, on the basis of the shape and dimensions of said reference.
- 25 • means designed to calculate the position and relative inclination of the axis of the hole in relation to said reference and to move said head so as to bring said surgical instrument guidance means into

axis with said hole, with the same inclination as the axis of the hole.

3. Pointing apparatus as claimed in claim 1, characterised in that it includes:

- a reference system designed to be viewed by an X-ray, fluoroscopic or other type of apparatus;
- 5 • a pointing system which contains a housing for a quick-release coupling of a terminal designed to support surgical instrument guidance means (such as a cannula);
- a terminal, fitted with surgical instrument guidance means, which is designed to receive the pointing system via a quick-release coupling;
- 10 • means designed to move said terminal close to the end of the nail containing the holes, to allow said external apparatus to take simultaneous images of the end of the nail with the holes and the reference integral with the terminal;
- means designed to read said image and calculate the position and
- 15 • inclination of its axis on the basis of the shape and dimensions of the hole shown in the image;
- means designed to read the image of said reference system and calculate the relative position and inclination of said reference system, and consequently of said terminal, on the basis of the shape and dimensions of said system;
- 20 • means designed to calculate the position and relative inclination of the axis of the hole in relation to said reference and/or pointing system and to move said terminal so as to bring said surgical instrument guidance means into the axis of said hole, with the same
- 25 • inclination as the axis of the hole.

4. Pointing and/or reference apparatus as claimed in claim 2 or 3, wherein said means designed to read the image taken by said external apparatus are constituted by a sensor connected via an interface to the output of said

external X-ray, fluoroscopic or other apparatus.

5. Pointing and/or reference apparatus as claimed in claim 2, characterised in that the reference system is integral with the head and is constituted by one or more radiopaque bodies of known shape, dimensions and position,
5 incorporated in said head.
6. Pointing and/or reference apparatus as claimed in claim 3, wherein the reference system is separate from the terminal and said terminal is designed to be connected to the reference system via a quick-release coupling and is fitted with means designed to guide a surgical instrument (such as a cannula), in a
10 known position in relation to the reference and/or pointing system.
7. Pointing apparatus as claimed in one or more of the preceding claims, characterised in that the reference is constituted by a plurality of radiopaque elements of known shape, dimensions and position.
8. Pointing apparatus as claimed in one or more of the preceding claims,
15 characterised in that said radiopaque elements are spheres with a known shape, dimensions and position.
9. Pointing apparatus as claimed in one or more of the preceding claims, characterised in that said radiopaque elements or spheres are located at the vertices of polygons of known dimensions.
- 20 10. Pointing apparatus as claimed in any of the preceding claims, characterised in that the head or terminal and the reference system are mounted on a support comprising a plurality of numerically controlled actuators designed to control their movements according to at least two linear directions orthogonal to one another, and their rotation around at least two
25 non-parallel axes.
11. Pointing apparatus as claimed in any of the preceding claims, characterised in that it includes a sterile hood, fitted to said head or terminal, which is designed to cover the supports and any other parts which come into

contact with the operating field.

12. Pointing apparatus for the correct positioning of the distal locking screws of an intramedullary nail, characterised in that it includes:

- a support which can be positioned in proximity to an operating table;
- 5 • a first movement system, mounted on said support, which is subject to the action of means that control its movements, under numerical control, along a first axis;
- a second movement system, mounted on said first movement system, which is subject to the action of means that control its movements, under numerical control, along a second axis;
- 10 • a reference and/or pointing system made of radiopaque material wherein the spheres are arranged in such a way that they are not superimposed with the intramedullary nail in the X-ray, fluoroscopic or other images, thus facilitating correct framing of the spheres and the target holes in the intramedullary nail;
- 15 • means provided with a quick-release coupling system for fitting to reference system 10a and suitably shaped to allow the fitting of cannula 13;
- means designed to receive in input an X-ray, fluoroscopic or other image file wherein the images of the end of the nail with the holes for the screws and said reference are taken simultaneously;
- 20 • means designed to process said images and consequently calculate the coordinates and inclination of the axis of the hole in relation to said reference, and to automatically calculate the length of the screw;
- means designed to activate the actuators of the slides in embodiment 25 1 or the upright and arm in embodiment 2 and the actuators of said supports, to move the surgical instrument guide on the terminal into axis with the hole in the nail.